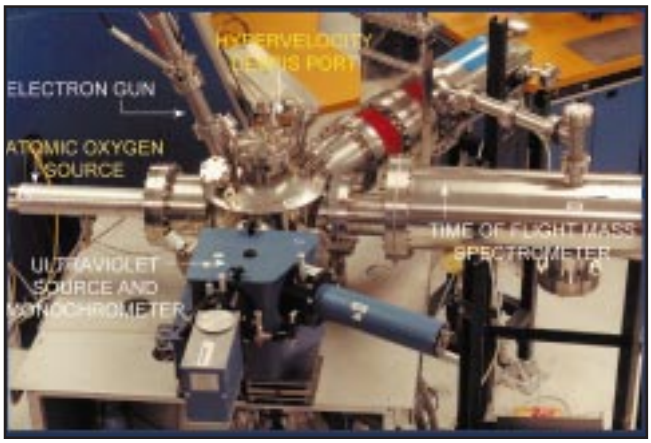
Synergism Between Space Environmental Components Increases Atomic Oxygen Erosion of Spacecraft



Payoff

Scientific members from the Air Force Research Laboratory (AFRL) and ONERA-Toulouse Research Center (ONERA-CERT), Toulouse, France, entered into a cooperative research project to gain an understanding of the interactive chemistry and the fundamental mechanisms by which erosion rates of organic polymers by atomic oxygen are enhanced by the simultaneous presence of electrons or spacecraft charging. This research project should save approximately six months and $200,000.

Accomplishment

A team of scientists from the United States and France are investigating the synergistic interaction between atomic oxygen and spacecraft charging which we have found produces an order of magnitude increase in the erosion rate of spacecraft materials. Through a cooperative research program arranged by the European Office of Aerospace Research and Development (EOARD), the French will investigate erosion rates using atomic oxygen ions on the same material Air Force Office of Scientific Research and Space Vehicles Directorate will use to study erosion using neutral atomic oxygen. In effect, the French will provide “controls” for our research, the results of which will help in the fundamental understanding of the reaction mechanisms which cause increased erosion rates of spacecraft materials in the presence of spacecraft charging.

Background

The Air Force and National Aeronautics and Space Administration (NASA) have begun to substitute lighter, stiffer, stronger organic composite materials for metal alloys to reduce launch weights and costs. However, spacecraft in Low Earth Orbit are exposed to a natural space environment, which is extremely hostile to composites, severely limits their ability to perform their mission and seriously reduces the longevity of the spacecraft. Understanding the fundamental mechanisms by which the space environment interacts with composites is required before hardening measures can be recommended to enhance the survivability of spacecraft. Materials degrade in space by interaction with atomic oxygen at rates significantly different than those projected from ground simulation tests. For example, using the apparatus shown in the accompanying figure, it was recently determined that the atomic oxygen erosion rate of polysulfone is increased by an order magnitude if the atomic oxygen exposure occurs in the presence of energetic electrons or charging of the polymer. During this cooperative research program, the VS Directorate will determine erosion rates using a completely neutral atomic oxygen beam. They will then compare them to the erosion rates measured by the French on the same lot of polysulfone material, using an atomic oxygen beam containing a known proportion of atomic oxygen ions. In the past, when a comparison of the results for many of the materials used for space experiments was made, ground simulation experiments performed on composite materials using atomic oxygen beams with unknown proportions of charged components do not corroborate each other. AFRL’s Materials and Manufacturing Directorate and EOARD provided $25,000 funding for VS's “control” portion of this research program.